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Wax appearance temperature (WAT) determinations of different origin crude oils by differential scanning calorimetry

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ABSTRACT

In this research, wax appearance temperatures (WAT) of eight different crude oils from south-eastern region of Turkey were determined by differential scanning calorimetry. The experiments were performed at a heating/cooling-rate of 2 °C/min from 60 to −20 °C It was observed that the wax appearance temperature of different origin crude oils was varied between 14.2 and 37.8 °C depending on the API gravity and wax content. It was also observed that the crude oils have enthalpy of precipitation ranging from −3.42 to +6.39 mW and melting enthalpy from – 2.5 to +7.46 mW, respectively.

1. Introduction

Crude oil is a complex mixture of hundreds of different chemical species consisting mostly of hydrocarbons known as paraffin's. In general, this paraffin's align as long straight chain molecules, branched or cyclic structures. It is known that paraffin wax produced from crude oil consists primarily of long chain, saturated hydrocarbons with carbon chain lengths of C_{18} to C_{75}, which is referred to as macro-crystalline wax.

The wax appearance temperature (WAT), also known as the cloud point, is an important characteristic to evaluate the possible wax precipitation of a given fluid. It is defined as the temperature at which a crude oil first precipitates. The techniques used to determine the WAT are visual, cold finger, cross-polarized microscopy, light transmittance and ultrasonic methods. Another method for WAT determination is using differential scanning calorimetry (DSC).

In general, DSC measures the heat flow from or to the sample when the sample is heated or cooled. Since crystallization will give out heat, it will show up in the DSC curve as an exothermic peak during cooling process. Since crystallization will give out heat, it will show up in the DSC curve as an exothermic peak during cooling. DSC is also useful to optimize chemical treatment parameters for cost-effective wax control, including selecting optimal wax crystal modifier and treatment formulation.

Depending on the geographic source and origin of crude oil, the amount of wax contained and wax appearance temperature varies (Table 1). In crude oils, when the temperature decreases, the dispersed paraffin's begin to align together and when this process continues the paraffin's form a solid crystalline wax structure and reaches a temperature where it precipitates out of the crude oil. This temperature is called wax appearance temperature (WAT). The wax appearance temperature, also known as the cloud point, is an important characteristic to evaluate the possible wax precipitation of a given fluid. On the other hand, as it is known, thermal methods are quite popular to determine the cloud point of petroleum fluids due to the high enthalpies of crystallization of the paraffin's (Elsharkawy et al., 2000; Won, 1986).

WAT of crude oils determined by DSC, thermos-microscopy, rheometry and other techniques has been studied by many authors. Bruning et al. (Bruning, 1990) studied the rheological properties of crude oils and concluded that the paraffin precipitation increases the system apparent viscosity, promoting complete loss of fluidity, depending on oil composition and temperature. On the other hand, Kruka et al. (Kruka et al., 1995) described the change e in the rheological behaviour is associated with formation and growth of paraffin crystals in the medium. Hansen et al. (1993) studied the wax appearance temperatures of crude oils by optical microscopy, viscometer and DSC under different experimental conclusions and concluded that DSC technique can provide values for WAT that are lower than other techniques. Taraneh et al. (2008) studied the inhibition of the crystallization and the melting point of crude oil samples using the rheological properties and determined that the improvement of the flow depends on the molecular weight and the amount of asphaltene in the sample. Lucas et al. (1993) studied the effect of additive on the pour point of the crude oils using a new procedure adapted from the ASTM method, which consist in the

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